

ECOLOGY AND DISTRIBUTION OF THE NORTH CENTRAL TEXAS ENDEMIC *DALEA REVERCHONII* (FABACEAE)

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ABSTRACT

Thirty-three new populations of *Dalea reverchonii* (Comanche Peak Prairie Clover) are reported from five additional counties in north central Texas: Bosque, Erath, Johnson, Somervell, and Tarrant counties. This expands the distribution of this Texas endemic from three counties to eight at a total of 69 sites. Habitat requirements, associated species, and threats are included and discussed. *Dalea reverchonii* is considered to be globally and state imperiled. The discovery of these additional populations and new county records may warrant modification of its conservation status.

RESUMEN

Se citan treinta y tres nuevas poblaciones de *Dalea reverchonii* (Comanche Peak Prairie Clover) en cinco condados adicionales del centro norte de Texas: condados de Bosque, Erath, Johnson, Somervell, y Tarrant. Esto expande la distribución de este endemismo de Texas de tres condados a ocho con un total de 69 lugares. Se incluyen y discuten los requerimientos de hábitat, especies asociadas, y amenazas. *Dalea reverchonii* se considera en peligro a nivel global y del estado. El descubrimiento de estas poblaciones adicionales y citas en condados nuevos podría justificar la modificación de su status de conservación.

INTRODUCTION

Dalea reverchonii (S. Watson) Shinnars was described in 1886 by Sereno Watson from an 1882 collection made by Julien Reverchon (1273, GH, NY, SMU, US) "on the rocky top of Comanche Peak" (Watson 1886), Hood County, Texas. Eggert recollected the species from Comanche Peak in 1900 (Mahler 1984). Several botanists have attempted to relocate the type locality on Comanche Peak but were unable to find any plants (Orzell 1987). In 1964 Barneby collected *D. reverchonii* in "limestone breaks" near Springtown in Parker County (Barneby 13529, NY). This collection represented the first time the species had been seen in 64 years. Mahler relocated this population in 1984 (Mahler 9594, SMU) and found several new locations in Parker and Wise counties (Turner 1959; O'Kennon 2010). Mahler (1984) recorded eight populations of *D. reverchonii* in 1984 but noted that "the actual observed populations are thought to reflect only a small percentage of the total number possible within the Grand Prairie." Barneby (1977) agreed with this sentiment saying "the species must be expected to turn up elsewhere around the northern fringes of Edwards Plateau."

Several surveys have been completed documenting the range of *Dalea reverchonii*, including Orzell (1987), Singhurst and Horner (1997), and McLemore and O'Kennon (2003). As of 2003 there were a total of 36 known populations, the majority of which were in Parker County. The population south of Springtown, which was discovered by Barneby, was estimated at over 1000 plants and was virtually destroyed by road widening, with only 23 plants remaining in 2003 (McLemore & O'Kennon 2003). In 2003, McLemore and O'Kennon relocated the type locality on the top of Comanche Peak for the first time in 103 years, where they found 11 plants (O'Kennon & McLemore 18793, BRIT).

Dalea reverchonii is a calciphile, known to grow only on rocky limestone substrate Cretaceous in age. Mahler (1984) described the habitat as "thin soil overlying limestone rock." Orzell (1987) noted that plants were found growing on a "nearly flat Goodland Limestone (Cretaceous Age) Glade surrounded by shrub thickets" (Orzell 5581, TEX). O'Kennon (2010) and Swadek and Burgess (2012) disagreed on the type of geology,

noting that the species is restricted to Walnut Limestone glades. Much of the Walnut (Kwa) and Goodland (Kgl) limestones are mapped as undivided units (i.e. Kgw), possibly leading to the uncertainty in geology. Comanche Peak, the type locality for the species, is topped with Edwards Limestone (Ked). *Dalea reverchonii* has only been collected in limestone substrate on what have been termed limestone glades by Swadek and Burgess (2012). These glades consist of little to no soil overtopping limestone bedrock.

As of 2003, this rare Texas endemic was only known from Hood, Parker, and Wise counties in Texas. *Dalea reverchonii* has a conservation rank of G2S2 (globally and state imperiled) indicating the species is at high risk of extinction "due to very restricted range, very few populations, steep declines, or other factors" (NatureServe 2013). The recent discovery of additional sites for several associate species suggests the possibility of finding additional *D. reverchonii* populations (Swadek & Burgess 2012; Taylor et al. 2012). Mahler (1984) believed "continued field research will undoubtedly produce more populations." The purpose of this study was to update the status of *D. reverchonii*, by surveying for additional populations and providing a thorough description of *D. reverchonii* habitat, including underlying geology and associated species.

METHODS

In 2011 the authors began an updated status survey of *Dalea reverchonii*. All known sites were revisited from spring 2011 through fall 2012 and population numbers were estimated. Associated species, geology, and habitat preferences were recorded. Satellite imagery and geologic maps were used to locate limestone outcrops representing habitat similar to that seen on known sites across nine north central Texas counties. All potential suitable habitat identified was searched for additional populations.

RESULTS AND DISCUSSION

Dalea reverchonii was found at 33 additional sites across eight north central Texas counties (Fig. 1). This brings the total number of sites to 69 and represents new county records for Bosque, Erath, Johnson, Somervell, and Tarrant counties. Population sizes ranged from one to several thousand plants, though most sites had fewer than 100 plants. The Aurora sites in Wise County were the largest population, consisting of an extensive system of linked glades. Each of the approximately 10 glade groups in the Aurora complex was estimated to have over 1000 plants. Population numbers are largest in Wise and Parker counties, with the populations in Bosque, Erath, Hood, Johnson, Somervell, and Tarrant counties typically consisting of fewer than 10 plants. Associated species include *Minuartia michauxii* (Fenzl) Farw. var. *texana* (B.L. Rob. ex Britton) Mattf., *Phemeranthus calycinus* (Engelm.) Kiger, *Sporobolus vaginiflorus* (Torr. ex Gray) Wood, *Hedyotis nigricans* (Lam.) Fosberg, *Heliotropium tenellum* Torr., *Hedeoma drummondii* Benth., *Plantago helleri* Small, *Erioneuron pilosum* (Buckley) Nash, *Opuntia phaeacantha* Engelm. var. *major* Engelm., *Tetraneuris scaposa* (DC.) Greene, and *Croton monanthogynus* Michx. Less common associates include *Pediomelum reverchonii* (S. Watson) Rydb., *Coryphantha sulcata* (Engelm.) Britton & Rose, *Dalea frutescens* A. Gray, *Bouteloua pectinata* Feath., *Paronychia virginica* Spreng., and *Yucca pallida* McKelvey. From Hood County southward, the following species were typically associated with *D. reverchonii*: *Erigeron modestus* A. Gray, *Linum rupestre* (A. Gray) Engelm. ex A. Gray, *Thelesperma simplicifolium* (A. Gray) A. Gray, *Verbena canescens* Kunth var. *roemeriana* L.M. Perry, *Vernonia lindheimeri* A. Gray & Engelm., and *Melampodium leucanthum* Torr. & A. Gray.

Dalea reverchonii appears restricted to crevices in exposed limestone bedrock, very shallow soils over bedrock, or Walnut marl where the shell hash has been removed (Fig. 2). The roots are embedded in the Walnut marl directly below the indurate *Texigryphaea mucronata* shell hash. The plant was rarely seen where vegetative cover is taller and denser, which seems to be associated with deeper soils overlying the limestone. The closely related limestone cedar glade endemic *Dalea gattereri* (A. Heller) Barneby has high light requirements and poor competitive ability, suggesting the species is endemic to limestone glades of Tennessee, Alabama, Georgia, Missouri, and Arkansas not because it prefers the habitat but because it is not shaded and outcompeted by other taxa (Breedon 1968). It is likely that *D. reverchonii* is restricted to limestone glades for similar reasons. Gankin and Major (1964) concluded that rare plants often occur in areas where light competition

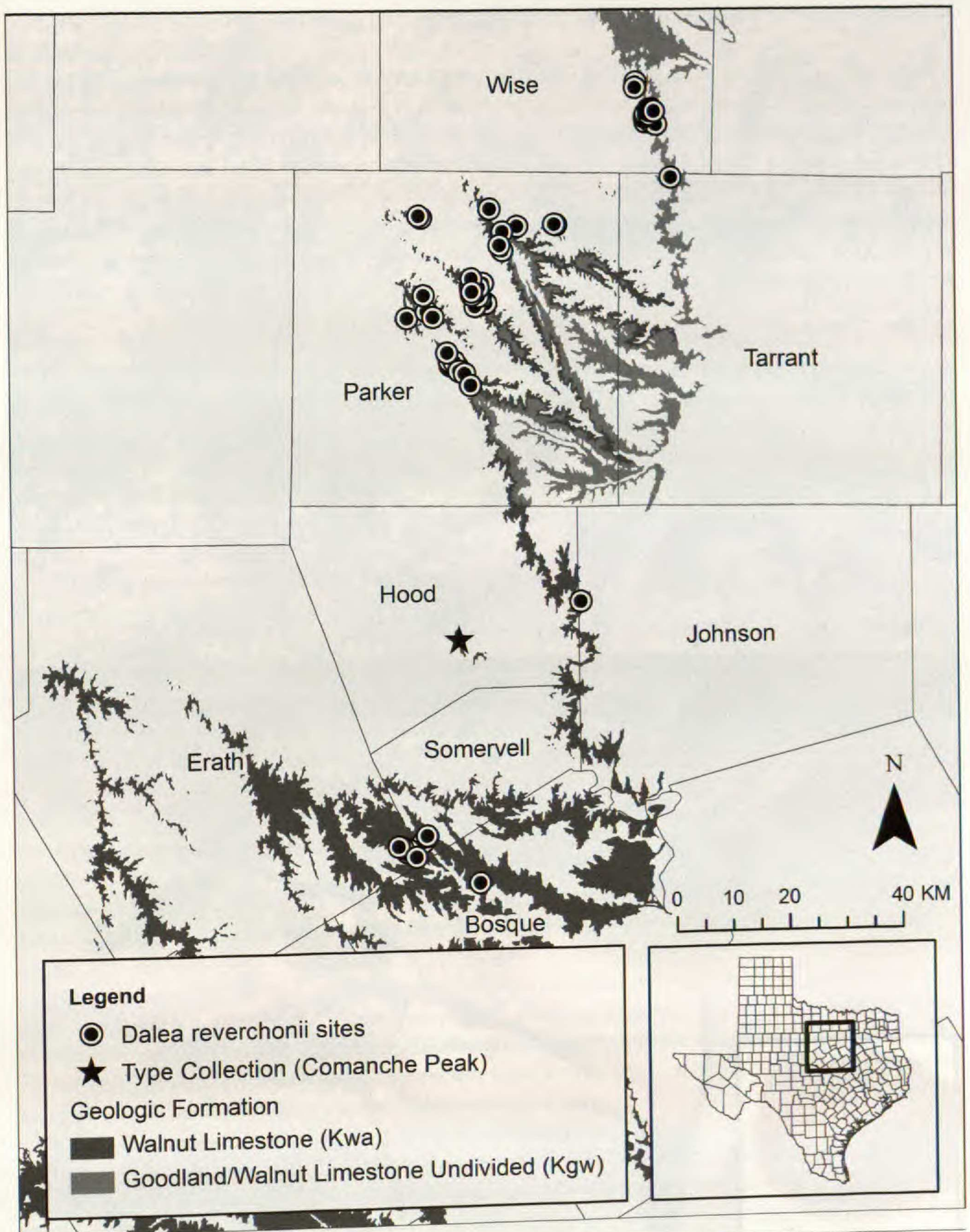


FIG. 1. Distribution of *Dalea reverchonii* in north central Texas. Thirty-three new populations were found including five new county records (Bosque, Erath, Johnson, Somervell, and Tarrant).

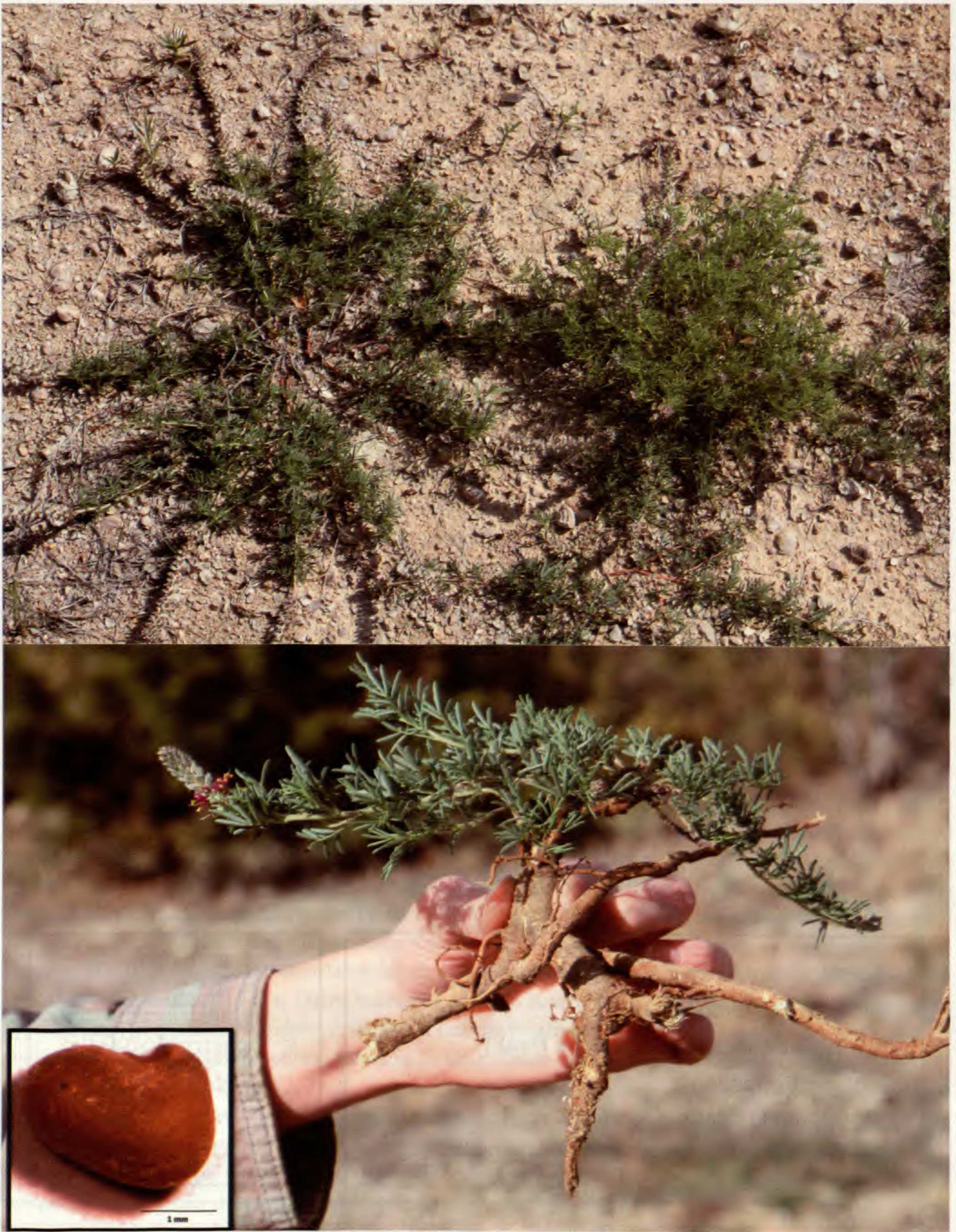


FIG. 2. **Top** – *Dalea reverchonii* plants showing prostrate habit of older plants (left) and more erect habit of younger growth (right). Photo taken 7 May 2011, New Highland Rd. site, Parker County. **Bottom** – *Dalea reverchonii* plant showing woody taproot and seeds (inset). Seeds have a hard coat and are 1.7×2.7 mm. Photo taken 11 Nov 2011, Summit Ridge glade site, Parker County.

from associated vegetation is decreased "by some extraordinary soil parent material . . ." (Baskin & Baskin 1988).

All *Dalea reverchonii* populations, with the exception of the Comanche Peak site, were found on texigryphaeid oysterbeds of the Walnut Limestone Formation (Fig. 3). In the northern and western parts of its range *D. reverchonii* sites tend to be on higher parts of the landscape, appearing as erosional remnants capping the softer Paluxy Sandstone below. In the southern and eastern parts of its range *D. reverchonii* tends to be at lower parts of the landscape where the softer Goodland/Comanche Peak Limestone or clays in the Fredericksburg group erode away exposing the harder Walnut caprock below. Therefore, *D. reverchonii* is typically found at the edges of the Walnut Formation near the contact with either the underlying or overlying strata. Thicker soil development above the hard *Texigryphaea* oyster beds, and the associated taller vegetation, rarely support the plant. Therefore populations will only be stable in areas where the bedrock remains exposed forming an edaphic climax community. This explains why the plant is not found further to the south on the Edwards Plateau where the Walnut Formation is quite expansive but is typically located in valleys and supports more developed soils. A few *D. reverchonii* sites were found where soil development was more advanced, and the plants were overtopped by annual and perennial grasses. These sites have likely progressed from open glades to deeper-soiled barrens as described by Quarterman (1950) for the cedar glades of central Tennessee. *Dalea reverchonii* could potentially persist for some time in glades where it was well established that have become overgrown, but population numbers would be expected to decline, ultimately resulting in extirpation from the site.

The *Dalea reverchonii* population from the top of Comanche Peak (Fig. 4) is the only known location for the species not in Walnut Limestone. The type locality is actually in thin soil on Edwards Limestone near the contact with Comanche Peak Limestone (very similar to Goodland Limestone to the North of Hood County) and far from (60 meters above) the Walnut Limestone. The peak base is surrounded by Walnut Limestone with an abundance of exposed bedrock similar to that at other *D. reverchonii* sites. This area is currently grazed by cattle which may explain the plant's absence from this otherwise ideal habitat. We hypothesize that the Walnut Limestone surrounding Comanche Peak historically supported a large population of *D. reverchonii*. The plants on the top of Comanche Peak were likely opportunistic and only survived due to the difficulty for cattle to reach them. The Comanche Peak population suggests that it is not the chemical makeup of the Walnut Limestone that determines the plants viability, but the edaphic conditions that the hard erosion-resistant caprock produces. These mesas capped with Edwards Limestone, which are similar to the cuestas of the Grand Prairie capped with Walnut Limestone, are abundant throughout the Lampasas Cut Plain south of Hood County (Hill 1901). These areas are mostly privately held ranch land and may represent an unexplored habitat for the species.

On surfaces stabilized by a caprock glade of Walnut Limestone, the vegetation tends to be lower, more open, and less grassy than typical mixed grass prairies. This vegetation may be part of the "Walnut Prairie" described by Hill (1901), which he recognized as distinct from the Fort Worth Prairie. This community should not be confused with mixed grass prairies, especially since it has at least one endemic plant species. It would promote greater awareness of the vegetation differences and appreciation of the unique geologic qualities if these landscape units were distinguished by some label other than "prairie." The processes structuring the vegetation seem to conform with the concept of glades and barrens described by Quarterman (1950).

Swadek and Burgess (2012) proposed the open rocky areas where *D. reverchonii* thrives be termed "Walnut Limestone glades." Proposing a name for the unique landscape and community that this species inhabits would aid stewards of environmental heritage in promoting the appreciation and conservation of this distinctive regional ecosystem. Swadek and Burgess (2012) define a Walnut Limestone glade as "open areas of exposed limestone outcrops and rocky areas with soils around 0 to 5 cm deep. *Texigryphaea* fossil shell fragments usually dominate surfaces."

These Walnut Limestone glades are both structurally and floristically "reminiscent of those found in the Central Basin of Tennessee" (Taylor et al. 2012). *Dalea gattingeri* fills the same ecological niche in the Tennessee



FIG. 3. Typical *Dalea reverchonii* habitat, Rocky Walnut Limestone glade with thin soil over exposed bedrock. Photo taken 24 Apr 2011, Utley site, Parker County, Texas.

cedar glades as *D. reverchonii* does in the Walnut Limestone glades. Both species in Series *Purpureae* thrive in shallow soil and cracks in exposed limestone bedrock (Barneby 1977). Baskin and Baskin (1988) suggest that marginal populations of widespread species, through catastrophic selection, "could result in narrow edaphic endemics...[and] may have played a role in the evolution of some of the rock outcrop endemic taxa, especially those that are closely related to widely distributed taxa within their geographic region." Both *D. gattereri* and *D. reverchonii* are on the margins of the geographic range of the closely related *D. purpurea* Vent. Catastrophic selection in marginal *D. purpurea* populations may have resulted in the evolution of both limestone glade endemic taxa.

Several threats exist to *Dalea reverchonii* including road widening, land development, spread of non-native plants, and livestock grazing. Perhaps the most severe threat is that of grazing by livestock. Other than the populations concentrated in Weatherford city limits, the majority of *D. reverchonii* sites remain in rural areas where land beyond the right-of-way has not been subdivided or platted. Much of *D. reverchonii*'s habitat remains rangeland and often appears ungrazed or only lightly grazed. Plants were rarely found in locations where livestock were present. In some cases, several plants would be found on the roadside but no plants would be found inside the fence where livestock were present. The plants do appear to be able to persist with mild grazing, but we predict that repeated intense grazing will ultimately result in the death of the large woody taproot and the death of the plant. The Aurora sites in Wise County are mildly grazed, but it appears the cattle tend to stay at higher elevations where vegetation is more abundant. The species was likely much more abundant prior to the 1800s when extensive conversion of land to pastures likely led to the destruction of many populations.

Non-native invasive taxa prove a threat to the species through competition and shading. Equally, prevent-



FIG. 4. Bob O'Kennon with *Dalea reverchonii* at the type locality on the top of Comanche Peak. Prior to 2003 the species had not been seen at this location since 1900. Photo taken 1 Aug 2003, Comanche Peak site, Hood County, Texas.

ing woody encroachment into the glades will be essential in maintaining viable populations. *Dalea reverchonii* appears to thrive in sites where the Walnut caprock has been removed, leaving the softer underlying marl exposed. These quarried sites appear to be well suited for *D. reverchonii* as scraping removes competing vegetation and the hard shell hash, allowing roots easy access to the Walnut marl. It is unclear if this success will persist as soils may develop and competing vegetation invade with the absence of the hard rock shell hash.

In 2005, *Dalea reverchonii* plants were transplanted to three locations in the Lyndon B. Johnson National Grasslands in Wise County. The plants that were introduced are thriving, but no new plants have come up from seed. This lack of recruitment is likely due to the hard seed coat (Fig. 2), but could have implications for establishment of new viable populations. An additional population was planted in the Fort Worth Nature Center and Refuge in Tarrant County in 2012. All reintroduced populations were planted on Walnut Limestone glades. It is likely that *D. reverchonii* plants would have historically occurred at both the LBJ National Grasslands and Fort Worth Nature Center and Refuge. A history of livestock grazing at both locations could explain their current absence from these locations. These transplanted populations represent the only populations on city, state, or federally protected land. *Dalea reverchonii* currently has a conservation rank of G2S2, but with this recent range expansion this rank may warrant modification.

Representative voucher specimens: **USA. TEXAS. Bosque Co.:** CR 2650 at Cr 2640, ca 1.5 mi W of Walnut Springs, hard pack limestone in fence line, 2 plants, 32.057893, -97.775105, elev. 284 m, 30 May 2011, O'Kennon 23497 (BRIT). **Erath Co.:** Rough Creek Lodge, Co Rd 2013 ca 4.2 mi SE of hwy 67, 10.4 mi SW of Glen Rose, growing on Walnut Limestone glade, 32.099184, -97.890129, elev. 334 m, 25 Nov 2011, O'Kennon 24574 (BRIT). **Hood Co.:** Comanche Peak. 4.5 mi S of Granbury, growing in thin, rocky soil over Edwards Limestone on rocky top of Comanche Peak, plants prostrate to the ground, 11 plants observed, collected from type locality. 32.381812, -97.803996, elev. 369 m, 5 Aug 2003, O'Kennon & McLemore 18793 (BRIT); 7 plants observed, 4 May 2011, Norton, O'Kennon, Kieschnick, Barfield, & Swadek 734 (BRIT). **Johnson Co.:** Intersection of Cleburne Hwy and Running Deer Ct, 4.9 mi E of Acton, growing on Walnut Limestone glade, 32.427929,

-97.616031, elev. 239 m, 10 Dec 2011, *O'Kennon 24597* (BRIT). **Parker Co.:** Corner of Highland Rd and New Highland Rd, ca 3 mi SW of Springtown, plants growing prostrate to the ground, very abundant, 32.927577, -97.648501, elev. 309 m, 6 May 2011, *Norton & O'Kennon 790* (BRIT). **Somervell Co.:** Rough Creek Lodge, Co Rd 2013 ca 4.2 mi SE of hwy 67, 10.4 mi SW of Glen Rose, growing on Walnut Limestone glade, 32.12214, -97.85769, elev. 324 m, 1 Dec 2011, *Norton & O'Kennon 1286* (BRIT). **Tarrant Co.:** FM 718 ca 1.5 mi SE of Newark on S side of rd, growing on Walnut Limestone glade, 4 plants, 32.988185, -97.462911, elev. 224 m, 25 May 2013, *O'Kennon 25829* (BRIT). **Wise Co.:** Private ranch ca 0.8 mi N of Aurora, Walnut Limestone glade, abundant, 33.070957, -97.495660, elev. 252 m, 8 May 2012, *Norton & O'Kennon 1691* (BRIT).

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